Introduction

Cubesat Laser Infrared CrosslinK (CLICK) Mission

CLICK Payload Facts

<table>
<thead>
<tr>
<th>Transmitter Architecture</th>
<th>MOPA, EDFA, MEMS FSM</th>
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<tbody>
<tr>
<td>Receiver Architecture</td>
<td>TDC, ADC</td>
</tr>
<tr>
<td>Bandwidth</td>
<td>0.71 urad (FWHM)</td>
</tr>
<tr>
<td>Rate</td>
<td>&gt; 20 Mbps @ BER 10^{-4}, Full Duplex</td>
</tr>
<tr>
<td>Communication Range</td>
<td>25 - 580 km</td>
</tr>
<tr>
<td>Range Resolution</td>
<td>&lt; 50 cm</td>
</tr>
<tr>
<td>Power, Mass, Volume</td>
<td>0.2 W Optical Power, 15 W Avg, 35 W Peak, &lt; 3 kg, &lt; 2U</td>
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</table>

CLICK Mission Communications Objective:

Full duplex laser crosslinks at 20 Mbps with a BER of 10^{-4} at ranges from 25 km to 580 km.

Motivation

- Matched Filters (MF) are well understood, frequently used in communication receivers, and exhibit the theoretical best performance [1].
- Time-to-Digital Converters (TDCs) are frequently used in applications that require precision event timing, such as ranging. The Deep Space Optical Communication (DSOC) Ground Laser Terminal plans to use TDCs with SNSPD technology [2].
- TDC performance in communication systems unknown. This work estimates the performance of a TDC in communication applications by developing a high-fidelity model for simulation to understand scenarios and environments best suited for each architecture.

Approach and Methodology

ADC + MF
- Well understood for communications,
- Reconfigurable for other applications
- Limited by sampling frequency
- Power scales with inverse of pulse duration
- Requires intensive post processing, high data volume output

TDC
- Well understood for ranging, provides cm level resolution
- Pulse duration can be decoupled from slot duration
- Power scales with pulse repetition rate
- Requires minimal post processing, low data volume output

ADC has higher performance in low SNR scenarios, but performance expected to converge around SNR of 2dB.

TDC performance better than ADC is result of finite samples in simulation. Not expected in implementation.

System Block Diagram

1. Determine signal power at the receiver APD with link budget analysis
2. Apply noise from electronics, detector, and background
3. Find the optimal threshold (statistics based) and on-orbit threshold (proportional to received power) for comparator preceding TDC
4. Timestamp edges from comparator output, demodulate, compare to transmitted data

Future Work

System expected performance predicted to match at ranges of interest. Model and results will be verified with CLICK flat-sat testing scheduled for completion in Fall 2018.

Citations


Acknowledgements

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Time-To-Digital Converter vs. Analog-To-Digital Converter and Matched Filter Performance in Nanosatellite Optical Receivers

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Approach and Methodology

Results

System expected performance predicted to match at ranges of interest. Model and results will be verified with CLICK flat-sat testing scheduled for completion in Fall 2018.

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